Soil biology

What kinds of living things might live in soil?

Background
Soil is an ecosystem that contains both living and nonliving factors. The living or biotic factors include many different types of organisms and live in a complex food web that encompasses predators, prey and producers. These feeding groups are made up of **bacteria** of various sizes and shapes. Healthy soils have many different types of bacteria: round, oval, or long tubular shapes (generally “good” bacteria; and oblong twisted, bean shaped, or long and skinny worm-like shapes (generally “bad” bacteria).

By Deuterostome - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=25530266

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Protozoa are heterotrophic organisms that may be parasitic or free-living. They require moist environments, either in fresh or brackish waters, or in soils. However, they may form cysts that will allow them to remain dormant during dry conditions. The cysts provide a protective membrane. Paramecium and amoebas are common examples of protozoa. An example of a protozoan using a protective cyst is an amoeba inside the gut of cattle. When the cow drinks extremely cold water and it reaches the cows stomach the amoeba will go back inside the cyst and stay there until the temperature rises and conditions are favorable. Paramecium are single-walled and have **cilia** or small hair-like structures that will propel it through water. Amoeba are double-walled protozoa. Some protozoa have **flagella** or a whip-like tail.

Fungi make up another group of organisms that spread **hyphae**, which create a net-like structure called **mycelium.** The hyphae absorb and transport nutrients, either from a host or the soil. There are harmful fungi including *Phytophthora,* which is responsible for root and crown rot and *Pythium*, which causes damping-off in seedlings.

Some fungi give off a protein called glomulin that gives soil structure or holds the soil particles together. Fungi have a uniformed diameter and branching within the hyphae that separate the cells. The wider the diameter of the hyphae and the darker the color, the better the fungi for soil. **Mycorrhizae** make up a group of fungi that have symbiotic relationships with plant roots. Mycorrhizae need carbohydrates and plant roots need these fungi to meet their nutrient needs. Unfortunately mycorrhizae are only visible with UV lights on microscopes or through the use of dyes to show fungi growth. These mycoorhizae species are specific to their hosts and are comprised of two types, ectomycorrhizae which surround the root of the host, or endomycorrhizae, which grow inside the plant root system and are more common in agriculture systems. Although we think that plants only absorb nutrients from the soil, they also are giving off up to 40% of the sugars created through photosynthesis in the form of **exudates**. These exudates signal microbes calling for nutrients to support the plant's root system. Fungi help to meet these nutrient needs.

Soil Health and Microbes

Caenorhabditis elegans, By Bob Goldstein, UNC Chapel Hill http://bio.unc.edu/people/faculty/goldstein/ Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6797591

Nematodes are small worms that are mostly "good guys" in the soil. They are more visible and can move quickly. They eat bacteria, fungi, each other and plant roots. There needs to be a balance. If your soil is highly disturbed you will not have fungi and without fungi there is less for nematodes to eat.

Several species of nematodes can cause problems by attacking crops and or spreading viruses to crops. ***Heterodera*** are parasites that attack different crops, often causing economic damage. The female is able to transform into a tough, brown, cyst to protect her eggs. Soybean cyst nematodes (SCN) cause damage to soybeans in many states.

Other nonliving things that might be visible in the soil sample are mineral components such as humic acid, clay and sand; and organic matter such as plant tissue, seed coats, pieces of wood or mulch.

Soil is a diverse natural ecosystem that we manage to grow our food. We want a diverse dynamic food chain in our soil: organisms living, eating, pooping, dying, and decaying.

We just need to provide the conditions and nature does the rest.

Materials

microscope (up to 400x)
test tubes
glass microscope slide
18 x 18 cover glass
1/8th of a tsp or ¼ tsp scoop
distilled or spring water (non-chlorinated)
lab squirt bottle
disposable plastic pipettes
2 empty cups (1 with chlorinated water and 1 as a dump cup)

Procedure

1. Collect multiple soil samples from different locations (ex. garden soil, farm plot soil, lawn soil).
2. Add ¼ tsp of a soil sample to a test tube with a lid for shaking.
3. Add about 5ml of water to test tube and replace the cap. This will create a 1 to 5 dilution of your sample.
4. Now gently shake with an up and down motion from bent elbow to shoulder for 30 seconds. (It is important to note that we do not want to harshly shake our sample. We are trying to find living organisms.) Do not radically shake.
5. Use a clean pipette to draw out the liquid, do your best not to get any large chunks that will clog your pipette and be too dense to allow light from the microscope to shine through.
6. Add a very small amount of the draw sample to your slide tray. (This should be about the size of a pea.) Gently place your slide cover over your sample and gently place it on the microscope and safely secure it with the slide arm to hold securely in place for viewing.
7. Adjust your microscope until you begin to clearly see the different sediment of your sample.

Soil Health and Microbes

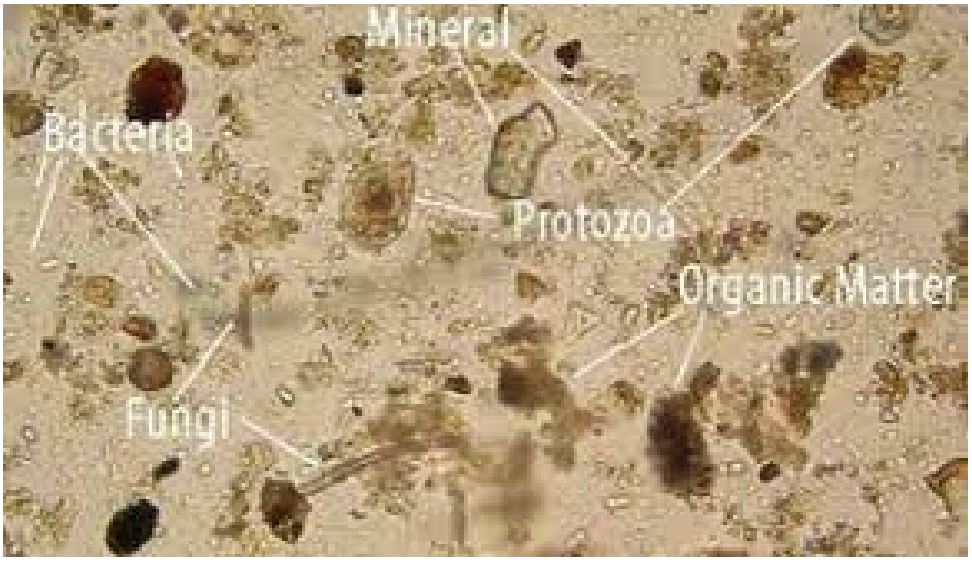
Lab Sheet

Before beginning the lab take a few minutes to draw in the boxes what you think the following might look like.

Nematode	Microarthropod	Fungus
Protozoa	Bacteria	Silica Crystals

Now that you have completed your pre-drawings, let's take a look at our soils.

What we are looking for?



Babur, Emre & Dindaroğlu, Turgay. (2020). Seasonal Changes of Soil Organic Carbon and Microbial Biomass Carbon in Different Forest Ecosystems. 10.5772/intechopen.90656.